Speculum Nauticum.

A

LOOKING GLASSE FOR SEA-MEN:

Wherein they may behold a ſmall Inſtrument called the Plain Scale: whereby all Queſtions Nauticall, and Propoſitions Aſtronomicall are very eaſily and demonſtratively wrought.

Publiſhed for the uſe and benefit of ſuch as will make good uſe of it.

By *John Aſpley*, Student in Phyſick, and Practitioner of the *Mathematicks*, in the Citie of *London*.

The fourth Edition corrected.

LONDON,
Printed by *Thomas Harper*, and are to be ſold by *George Hurlock*, at his ſhop at Saint *Magnus* corner.
1647.

TO THE WORSHIPFVLL
THE MASTER, WARDENS,
And Assistants, of the *Trinity House*
in *Deptford Strand.*

ALbeit (*Right Worshipfull*) there be more essential natures contained in each part both of this *Macrocosme*, and *Microcosme*, existing in their absolute being, than the understanding of man can fully apprehend; yet I doubt not, but those which may with labour and diligence be known, & those also which of ingenious spirits and notable wits have been invented, and by them artificially & methodically taught, (tending not onely to manifest profit in

the Common-wealth, but alſo to the great increaſe and ſetting forth of Gods divine power, wiſdome, goodneſſe, providence, and increaſe of Virtue ought of all men to be imbraced, (and eſpecially of thoſe which have any government, publike charge, or authority in the Common wealth.) In regard that the neerer men approach to ſuch excellent Vertues, the neerer (without doubt) do they come unto goodneſſe, to felicyty, and to God himſelfe. Hence ſaith the Prophet (unto men ſeated in eminent places) *Dixi vos dii eſtis*, ſo that thoſe which either through arrogance, or ignorance deride, and contemne thoſe Arts (which with great dexterity, care, and induſtry have bin found out, and left unto us by the love of our Predeceſſors) doe both offer contempt unto the goodneſſe of God, and do much endamage and anoy all humane ſociety. So on the contrary part, they that do by all means further

thoſe

those so profitable Disciplines doe both render true honour unto GOD, and do greatly advance the good of the Common-wealth wherin they live. Now in regard there is no study (Divinitie excepted) wherein the wit of man may be better employed then in the motion of the stars, and in the knowledge of their situation, place, and being, together with their wonderfull effects: In regard wherof I was incited to imploy some of my time in the study therof, and at last considering that of the Orator, that *Non solum nobis nati sumus, &c.* We are not born for our selves onely, but our friends challenge a part in us, and our Countries come in for a share, especially those honours and graces of our Countrey, *those that traffique in the deepe, and have their busines in the great waters*, those that are unto this Island as a wooden wall, the Sea-chariots, and the horses of *England*: these, I say, may claime justly

justly to the fruits of our labours, whatsoever they be which have not altogether been abhorrent from the Mathematicall studies: considering this, I could do no lesse than bring in this my mite into their treasury, and *Si quid Ars mea efficere possit*, (if my skill can stand them in any stead) to further that so much deserving Science of Navigation. Accept therefore, *I* beseech you, this yong sonne of my studies, this little handfull of paper, wherin is contained not *Anacreons* wanton Odes, or *Ovids* lascivious Elegies, the incendiaries of lust, but a pure spark of chast Vestal fire, a small part of the Mathematicks dedicated from a serviceable affection to your VVorships, that under the shield of your protections it may live secure, from the desperate stab of of criticall persons, and envious spirits, who not onely like snarling *Satyres* deride and contemne those so liberall Sciences, but

swallow

ſwallow up with deſpite (if it were poſſible) the profeſſours thereof. For reſcue from ſuch malignant ſpirits my Book flies to the ſhadow of your favour, which if you ſhall afford unto it, my labours ſhall be all ſacrificed unto you, and I reſt.

Your Worſhips bound ſervant,

IOHN ASPLEY.

To the Reader.

HAving ever ſince I came unto underſtanding (courteous Reader) practiſed my ſelfe in the Mathematicall ſtudies: and having attained unto my deſires therein, I am willing to impart ſome of that knowledge which God hath beſtowed upon me, unto the open view of the World: for the manifeſtation wherof, I have freely given unto thee this ſmal Book, being the firſt fruit of my labours, containing ſuch Aſtronomicall and Nauticall Queſtions as are wrought by the plaine Scale: which if I ſhould finde to receive as free acceptance from thee, expect more of my labours in the ſame kind, and untill then I reſt.

Thy friend in affection,

IOHN ASPLEY.

Speculum Nauticum.

OR THE

SEA-MANS GLASSE.

THE FIRST BOOK.

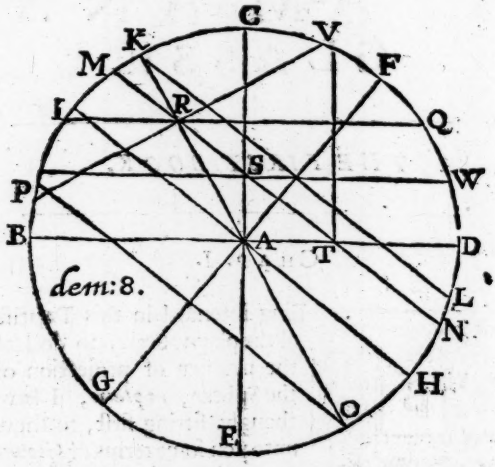
CHAP. I.

BEing intended in this Treatiſe of the playne Scale, to declare the manner of projection of the Sphear, *in plano*, I have thought fitting firſt, to ſhew unto you ſome terms of *Geometry* which are neceſſary for the unlearned to know (for whoſe ſake chiefly I write this Treatiſe) before they enter

into the definition of the Spheare. Firſt, therfore I intend to relate unto you, what a point or prick is, and afterward a Line both right and crooked, and ſuch ſorts thereof as are appertinent unto the operations and uſe of this Scale.

Punctum, or a Point, is the beginning of things, or a prick ſuppoſed indiviſible, void of length, breadth, and depth; as in the figure following is noted by the Point or Prick A.

Linea, or a Line, is a ſuppoſed length, or a thing extending it ſelfe in length, not having breadth nor thickneſſe, as is ſet forth unto you by the Line B A D.



Parallela, or a Parallell Line, is a Line drawne by the ſide of another Line, in ſuch ſort that they may be

be equidistant in all places. And of such Parallels two only belong unto this work of the plain Scale, that is to say, the right lined parallell, and the circular Parallell.

Right lined Parallells, are two right lines equidistant one from another, which being drawn forth infinitely, would never touch or meete one another, as you may see in the figure where the line H.I. is Parallell unto the line C.E. and the line G. F. is Parallell unto them both.

A circular Parallell is a Circle drawn eyther within or without another Circle upon the same Centre, as you may plainly see by the two Circles B.C.D.E. and X.V.Y.W. These Circles are both drawne upon the Centre A. and therefore are Parallell the one unto the other. There is another kinde of Parallell also, which is called a serpentine Parallell, but because it is not belonging unto the use of this Scale, I will omit it and so proceede unto the rest.

Perpendiculum, or a Perpendicular is a Line raysed from, or let fall upon another Line, making equall angles on both sides, as you may see declared in the figure, wherin the Line A. C. is perpendicular unto the line B.A.D. making equall angles in the point A.

Diameter Circuli, or the Diameter of a Circle, is a right Line drawne thorow the Centre of any circle, in such sort that it may divide the Circle into two equall parts, as you may see the line B.A.D. is the Diameter of the Circle B.C.D.E. because it passeth thorow the Centre A. and the two ends therof do divide the Circle into two equall parts, in the two extrems B. & D making the semicircle B. C. D. equall unto the semicircle D.E.B.

Semidiameter circuli, or the Semidiameter of a Cir-

cle, is halfe of the Diameter, and is contayned betwixt the Centre, and the one ſide of the Circle, as the Line A D, in the Semidiameter of the Circle B C D E.

Semi-circulus, or a Semi-circle, is the one halfe of a Circle, drawne upon his Diameter, and is contained upon the Superficies, or Surface of the Diameter, as the Semicircle B C D, which is halfe of the Circle B C D E, and is contayned above the Diameter B A D.

Quadrans circuli, is the fourth part of a Circle, and is contayned betwixt the Semidiameter of the Circle, and a line drawn Perpendicular, unto the Diameter of the ſame Circle, from the Centre thereof, dividing the Semicircle into two equall parts, of the which parts, the one is the quadrant, or fourth part of the ſame Circle. As for example, the Diameter of the Circle B C D E, is the line B A D, dividing the Circle into two equall parts: then from the Centre A, raiſe the Perpendicular A C, dividing the Semicircle likewiſe, into two equall parts, ſo as A B C, or A C D, the quaſired.

CHAP.

Chap. II.

The manner how to raiſe a Perpendicular from the midle of a Line given.

DRaw firſt a ground line whereupon you would have a Perpendicular raiſed, then open your Compaſſes unto any diſtance (ſo it exceed not the end of your line,) placing one foot of the ſaid Compaſſes, in the point from whence the Perpendicular is to be raiſed, and with the other foot make a mark in the line on both ſides, then removing your Compaſſes, unto any other diſtance that is greater, and ſet one foot therof, in one of the marks, and with the other foot make a mark over the middle point, then with the ſame diſtance of your compaſſe, ſet one foot in the other mark upon the Line, and with the other foot make another arch of a Circle over the middle point, ſo that it may croſſe the firſt arch, and from the meeting of theſe two arches, draw a right Line unto the middle point, from which the Perpendicular was to be raiſed, which Line ſhall be the Perpendicular deſired.

Example, ſuppoſe your Baſe or ground Line whereupon a Perpendicular is to be raiſed by the Line F L K, and from L, the Perpendicular is to be raiſed, ſet one foot of your Compaſſes in the point L, and with the other, make the marks G, and M, on both ſides of the point L, then opening your Compaſſes wider, ſet one foot in the point M, and with the other draw the arch S, over the point L, then with the ſame diſtance of your Compaſſes, ſet one foot in G, and with

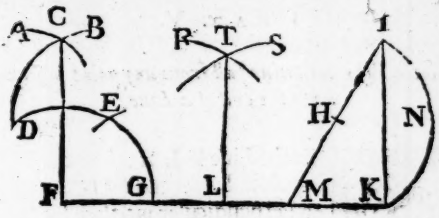
the other make the arch R. croſſing the arch S. in the point T. then from T. draw the Line T. L. which Line is Perpendicular unto the Line F. L. K. from the point L, which is the Perpendicular deſired.

CHAP. III.

To let a Perpendicular fall from any Point aſſigned, unto the middle of a Line.

LEt the line whereupon you would have a Perpendicular let fall, be the Line L F K, and the Point aſſigned, to be the point T, from whence you would have a Perpendicular let fall upon the Line F L K, firſt ſet one foote of your Compaſſes in T, and open your Compaſſes unto any diſtance, ſo that it be more than the diſtance T L, which here wee ſuppoſe to bee the diſtance T M, then make in the Line F L K, the marks G, and M, then with your Compaſſes, take the one halfe of G M, which is in the point L, then from L, draw a Line unto the point T, ſo the Line T L, ſhall be the Perpendicular, which was deſired to be let fall from the aſſigned point T, unto the middle of the Line F L K.

CHAP.



CHAP. IV.

To rayſe a Perpendicular upon the end of a Line.

SUppoſe the Line whereupon you would have a Perpendicular rayſed, be the Line F L K, and from the point F, a Perpendicular is to be rayſed: firſt open your Compaſſes unto any diſtance, which here we put to be the diſtance F G, & ſet one foot of your compaſſes in the point F, and with the other draw the arch D E G, then ſet one foote of your Compaſſes in the point G, and with the other draw the arch E, then placing one point of your Compaſſes in F, with the other draw the arch D B, then place your Compaſſes in D, and with the ſame diſtance, draw the arch A, cutting the arch D B, in C, then draw a Line from C, unto the end of the Line F L K, unto the aſſigned point F, ſo ſhall the Line G F, be a Perpendicular, rayſed from the end of the Line F L K, and from the aſſigned point F.

CHAP.

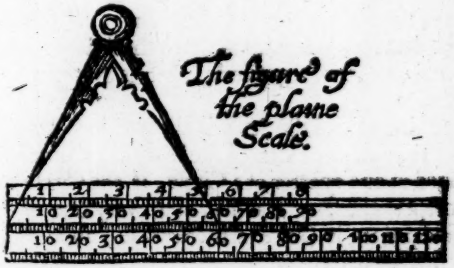
Chap. V.

To let a Perpendicular fall from any point aſſigned unto the end of a Line.

Et the Line F L K, bee the Baſe or ground Line, and from the point I, a Perpendicular is to bee let fall upon the end of the Line K, firſt from the aſſigned point I, draw a Line unto any part of the Baſe, which ſhall be the Line I H M, then finde the middle of the Line I M, which is at H, place therefore one foote of your Compaſſes in the point H, and extend the other unto I, with which diſtance draw the arch I N K, upon the Centre H, cutting the Baſe or ground-line in the point K, then draw the Line K I, which Line ſhall be the Perpendicular deſired.

NOW I doubt not but you underſtand the way to let fall, or to rayſe, any manner of Perpendicular Line, eyther from, or upon any part of a Line: therefore now I intend to proceede unto the maine point here aymed at, which is, to declare, and make known unto you the ſeveral operations performed by the plain Scale, which though it be in uſe with very few, yet it is moſt neceſſary with Sea-men, becauſe all queſtions in Navigation are thereby eaſily and plainly wrought. And alſo all queſtions in Aſtronomy (belonging unto the expert and induſtrious Sea-men) may both ſpeedily and eaſily be wrought by the ſame Scale: in regard whereof I have declared in this little Book, that knowledge (which God hath beene pleaſed

ſed to beſtow upon me) concerning the neceſſary uſe and practice therof; hoping that you will as kindly accept it, as it is freely offered unto your courteous conſiderations.



CHAP. VI.

Of the deſcription of the Scale.

THis Scale uſually is divided into three parts, the firſt wherof is a Scale of equall Leagues, divided into Degrees, or Leagues from 1 unto 100. and upwards, at your pleaſure, and numbred with 10 20 30 40, and ſo forth unto the end. All theſe diviſions are equall one unto another, and is in uſe for to meaſure the leagues that any ſhip hath run upon any courſe, or the leagues that ſhe hath raiſed or depreſſed the Pole, or departed the Meridian, as in the worke hereafter ſhall be more fully declared.

The ſecond part of the Scale, is the ſingle Corde

of a Circle, or the Cord of 90, and in dividing into 90, unequall diviſions, repreſenting the 90, deg. of the Quadrant : and are numbred with 10,20,30,40, &c. unto 90. This Cord is in uſe to meaſure any part, or arch of a Circle not ſurmounting 90 degrees: The number of theſe degrees from 1 unto 60, is called the Radius of the Scale, upon which diſtance, all Circles are to be drawne, whereupon 60 of theſe degrees are the Semidiameter of any Circle, that is drawn upon that Radius.

The third part of the Scale is divided into 8 parts, repreſenting the 8 points of the Mariners Compaſſe, contained in one quarter of a Circle, if the Circle bee drawn upon the ſame Radius, and every one of the aforeſaid points, is (for exactneſſe ſake) ſubdivided into 8 ſmaller parts.

I have likewiſe cauſed two other lines to be placed upon the back ſide of the Scale, which I doe call the firſt and ſecond Lines of Longitudes : the firſt is divided into 20 unequall parts, or leagues, which 20 Leagues are equall unto the Cord of 90. The uſe of this firſt Line of Longitude, is to ſhew how many Leagues and Miles in any Parallell, doe anſwere unto one degree of the Equinoctiall.

The ſecond Line of Longitude is divided into 100 proportionable parts, or into 100 unequall Leagues; and every league is ſubdivided into miles, and halfe miles. The uſe of this Line is thus : when you have found by the firſt Line of Longitudes, how many Leagues and Miles doe anſwere unto a degree of the Equinoctiall in any latitude you deſire: this ſecond line will ſhew you how many degrees any number of leagues in that Parallell, will anſwere unto a degree in the Equinoctiall Circle.

Thus

Thus having ſhewed you the parts of the Scale, and unto what uſe they doe generally ſerve, I will proceede to declare the particular uſe thereof, in the Art of Navigation, as followeth.

Chap. VII.

To finde how much any Ship hath raiſed or depreſſed the Pole, knowing the courſe ſhe hath made, and the leagues ſhe hath ſayled.

He Courſe is Southweſt and by South, the Leagues ſayled are 100, the difference of Latitude is demanded.

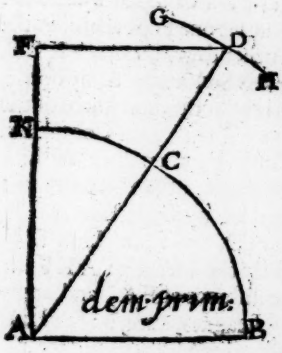
In the firſt Demonſtration, draw firſt the Line A B, and upon the Centre A, raiſe a Perpendicular A F. Then opening your Compaſſes unto the *Radius* of your Scale, and ſet one Foot therof in the Center A. and with the other draw the Arch K C B, then in regard your courſe is Southweſt & by South, that is three points from the South, take three of the eight points of the Compaſſe with your Compaſſes, and place them from K, unto C, then draw the Line A C D, and place the diſtance of the Leagues you have ſayled (which) are 100. upon the Line A C D, from A, unto D. Then from D, draw the Line D F. Parallell unto A B, cutting the Meridian A K F, in the point F, then take the diſtance of F A, and apply it unto the Scale of equall Leagues, and you ſhall find it juſt 83 Leagues, or 4 Deg. 9, Min. which are the degrees you have altered the Latitude, which degrees and minutes (if the Latitude from whence you departed, be South) muſt bee added unto the Latitude

from whence you departed, and you shall have the Latitude that you are in: contrariwise, substract them (if the Latitude from whence you departed, be North) and you have likewise the Latitude that you are in.

Chap. VIII.

The distance of Latitude and Leagues sayled being given, to finde the distance Meridional, and consequently the difference of Longitude.

Sayling from the North Parallell of 56. deg. and 5. min. 100. Leagues betwixt South and West, untill the Pole be depressed 4. deg. 9 min. the difference of Longitude is demanded.



IN the first demonstration draw the Quadrant A K C B, as is taught in the last Chapter. Then reduce your degrees of Latitude into Leagues, which is done by multiplying of them by 20 the product will be 83 leagues, which leagues being applied unto the Meridian Line A K F, they will end in the point F, Then from F, draw the Line D F, Parallell unto A B, Then open your Compasses unto the distance of 100. leagues of your Scale of equall parts, and

and ſet one foote of your Compaſſes in the point A, and with the other draw the arch G H, cutting the Line FD, in D, ſo ſhall the diſtance D F, bee the diſtance of the Meridian, from the Meridian, from whence you departed, which (being applyed unto the Scale) is 56 leagues. Then in regard you ſayled from the North Parallell of 56 deg. and 5 min. untill you had depreſſed the Pole 4 deg. 5. min. Subſtract therefore 4 deg. 9. min. from 56 deg. 5 min. and there remayneth 51 deg. 56 min. which is the latitude of the place you are in, and in that Parallell have you departed the firſt Meridian 56 leagues. Then opening your Compaſſes unto 51 deg. 56 min. of your Cord, and apply it unto the firſt Line of Longitudes, and you ſhall finde that 12 leagues and one mile (in that Parallell) doe alter one degree of Longitude. Then ſet one foote of your Compaſſes in the ſecond Line of Longitude, at 12 Leagues, one Mile, and extend the other unto one degree of that Line; then with that diſtance ſet one foot of your Compaſſes in 56 leagues of the aforeſaid Line, and the other will extend unto 4 degrees 33 min. which is the diſtance Meridionall deſired.

CHAP. IX.

diſtance of Lvtitude and diſtance Meridionall, given to finde the Rhombe.

Ayling from the North Paralell 69 degrees 20 min. untill the Pole be depreſſed four degrees and 9 min. and the diſtance Meridionall, or difference of Longitude, ſix degrees to finde the Rhombe is required.

By the firſt Demonſtration, draw the Quadrant A K C B, then turne your four degrees nine minutes into Leagues, it maketh eighty three Leagues; which place upon the line A K F, from A, unto E, then ſubſtract the difference of the two Latitudes, from the number of the firſt Latitude, and it leaves the ſecond Latitude 62 deg. 11 min. Then opening the Compaſſes unto the middle Latitude, which is ſixty four degrees, and fifteen minutes of the Cord, applying it unto the firſt Line of Longitudes, and you ſhall finde eight Leagues, two miles, and four ſeconds to anſwere unto one degree: then ſet your Compaſſes in one degree, in your ſecond Line of Longitudes, and extend the other foote unto eight Leagues, and two miles, and four ſeconds: then with that diſtance of the Compaſſes, place the one foot at ſix degrees of that line, and turne the other upward, and it will extend unto fifty ſix leagues, therefore open your Compaſſes to the diſtance of fifty ſix Leagues, in the line of equall leagues, and apply them from the point P, upon the line F D, parallell unto A B, from F, unto D, then from the point D, draw the line

line D A. cutting the Quadrant K C B, in C, ſo ſhall K C, be the diſtance of the Rhombe from the South Weſtward, which is juſt thirty three degrees, forty five minutes from the South, which is Southweſt and by South, the Rhombe deſired.

Chap. X.

By the Latitude of two places, and diſtance upon the Rhombe to finde the leagues ſailed.

The Pole depreſſed three degrees thirty minutes, the Rhomb the fourth from the Meridian.

IN the ſecond Demonſtration draw the line A E, then from A, raiſe the Perpendicular A C, then opening the Compaſſes to the diſtance of the Radius, placing one foot thereof in the Centre A, and with the other draw the Quadrant B D E, Then reduce your three degrees, thirty minutes into leagues, counting for every degree twentie Leagues, and for thirty minutes ten Leagues, ſo they make ſeventy Leagues; then open your Compaſſes unto ſeventy degrees in the line of equall parts, and place them upon the line A B C, from A, unto C, then from C, draw the line C F, Parallell unto A E. Then in regard your Rhombe was the fourth from the South, take foure of the eight points of the Compaſſe, and place them upon the

the Quadrant from B, unto D, then from A, by the point D, draw the line A DF, cutting the line CF, in F. So shall the distance betwixt A, and F, bee the number of leagues (upon the fourth Rhombe) before you can either raise or depresse the Pole three degrees thirty minutes, which is here found to be ninety nine Leagues.

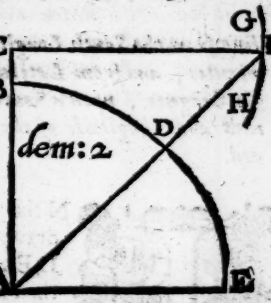
CHAP. XI.

To finde the distance of any Island from you, that you may discerne by two Stations, knowing the point of the Compasse, the Island beareth unto each of the Stations.

Suppose (being at Sea) you discover an Island bearing South-west of you, which place let it be your first Station, and seventy Leagues sayling South observing the Island to beare West of you, which let be the second Station, the demand is to finde the Island from both the Stations.

IN the second Demonstration let A, be the first Station, and upon the Centre A, draw the quadrant ABDE, then in regard you found the Island to beare South-west from you, therfore take four of your eight points of Compasse, and place them upon your Quadrant from E, unto D, then from the Centre A, by

by the point D, draw the Line A D F, repreſenting the viſuall Line paſſing betwixt your ſight and the Iſland, being in the firſt Station. Then ſayling ſeventy leagues South, which is from A, your firſt Station; unto C, the ſecond Station: then obſerving the Iſland to beare Weſt of you, therefore from the point C, the ſecond Station, draw the Line



C F, parallell unto A E, cutting the Line A D E, in point F, ſo ſhall the point F, be the place of the Iſland deſired, and the diſtance A F, is the diſtance of the Iſland from the firſt Station, which is juſt ninety nine Leagues off the Line of equall parts. And likewiſe the diſtance from C, unto F, is the diſtance of the Iſland from the ſecond Station, which is here found to be juſt ſeventy Leagues: and by this manner of worke you may finde the diſtance of any Iſland from you, which you may diſcerne either by Sea or Land.

Chap. XII.

Sailing from the South Longitude of 60 degrees, 51 minutes, and from Latitude 25 degrees, 24 min. 99 Leagues, upon a South-west course: the Latitude and Longitude of the second place is demanded.

IN the second Demonstration, draw the Quadrant A B C D E, as is formerly taught: then in regard you sail South-west, take foure points of the Compasse from your Scale, & place them from B, unto D, then by the point D, draw the line A D F, then place your ninety nine Leagues upon the Line A D F, from A, unto F, so shall E, be the place of your Ship. Then from F, draw the Line F C, parallell unto A E, cutting the line A B C, in C, so let the distance C A, be Leagues that you have run South, which is 70 Leagues, or 3 deg. 30 min. which being added to the latitude from whence you departed, makes sixty foure degrees and twenty one minutes for the Latitude of the second place: then take the distance C F, and apply it unto the Line of equall parts, and you shall finde it likewise seventy Leagues: then opening your Compasses unto the middle Latitude 62 degrees, 36 minutes in the Line of Cordes, and apply it unto the first Line of Longitudes, you shall finde that nine leagues and 0 miles, and 38 seconds, doe alter a degree of longitude, then placing one foot of your Compasses in the second line of longitudes,

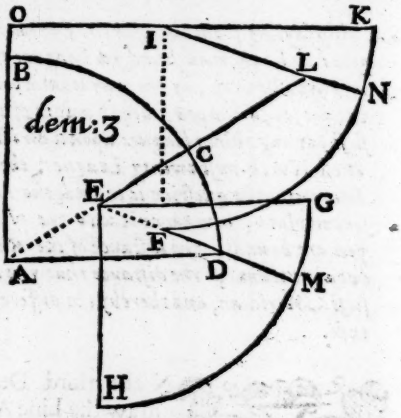
gitudes, at 9 leagues and thirty eight ſecends, and extend the other to one, then keeping the diſtance of the Compaſſes, ſet one foot in the ſeventy leagues of the ſame line, and the other foot will extend unto 7 degrees 37 min. which being ſubſtracted from the longitude from whence you departed, leaves ſeventeen degrees, and forty ſeven minutes for the Longitude of the ſecond place.

CHAP. XIII.

A Ship ſayling from the North Parallell of fifty degrees, having an hundred Leagues to ſaile South-weſt, and by Weſt, by the way is inforced by contrary windes, to ſaile upon ſeverall points of the Compaſſe, firſt ſayling thirty leagues upon a direct courſe, then Weſt North-weſt twenty Leagues, then South ſixty Leagues, the queſtion is to finde the Latitude of the ſecond place, how farre it is to the place whereunto you are bound, the diſtance of the Rhombe that is betwixt them, the diſtance that you are from your firſt Meridian, and thereby the difference of Longitude.

IN the third Demonſtration, draw the Line A D, and from the point A, raiſe the perpendicular A B, then open your Compaſſes unto the Radius of your Scale, and place one foot therof in the centre A, & with the other draw the Quadrant B C D, then take three points of the Compaſſes, and

and place them upon the Quadrant from D, unto C, then from the Centre A, by the point C, draw the line A C L, 100 Leagues in length, which is the true course you are to saile. Then in regard you sayled 30 leagues direct, take thirty degrees from your Scale of equall parts, and place them upon the line A E C, extending from A, unto E, then in regard you turned your Course, West, Northwest, from the Centre E, draw the Line E G, parallell unto A D, and againe from the Centre E, draw the Line E H, Perpendicular to E G, and parallell to A B, then with the distanee of the Radius, set one foot of your compasses in the Centre E, and with the other draw the quadrant G M H, and in regard you sayled West, Northwest, which is 2 points from the West, Northward, take from your Scale two points of the Compasse, and place them upon the Quadrant G M, H, from G, unto M, then from the Centre E, unto the point M, draw the line E F M, then take twenty leagues with your Compasses from the Scale of equal parts, and place them upon the line E F M, from E, unto F, then is your Ship in the point F. Lastly, in regard



gard you run South ſixty Leagues, from F, draw a Line Parallell unto the Meridian A B, which is the line F I, then take from your Scale of equall parts 60 Leagues, and place them from F, unto I, then is your Ship in the point I, then laſt of all is to be found how far it is to the place whereunto you were bound, the diſtance of the Rhombe that is betwixt you, the degrees and minutes you have raiſed the Pole, the diſtance of departure from the firſt Meridian, and thereby the difference of Longitude, and that you may ſo doe, firſt draw the Line O I K. Perpendicular unto the line I F, in the point I, and with your Compaſſes opened unto the diſtance of the Radius, ſet one foot of your Compaſſes in the Centre I, and with the other draw the Quadrant K N F, then in regard your ſhip is in the point I, and the place whereunto you are bound in the point L, therefore from I, thorow the point L, draw the Line I L N, cutting the Arch K N F, in the point N, therefore let I L, be the Leagues you have unto the place whereunto you are bound, which is forty one Leagues and a halfe, and the Rhombe the diſtance K N, which is Weſt, and by North, and three degrees unto the Northward, ſo likewiſe is the line A O, the number of Leagues you have run due South, which is 68 Leagues and one Mile, or 3 degrees and 25 minutes, which being taken from 50 degrees, the parallell from which you departed, leaves 46 degrees and 35 minutes for the Parallell you are in. Laſt of all, ſhall the line I O, be the Leagues that you have departed your firſt Meridian, which are 42 leagues and one mile: then open your Compaſſes unto 48 degrees 17 minutes and 30 ſeconds of the line of Cords, which is the middle Latitude, and apply it unto the firſt line of Longitudes, you ſhall finde that

13 Leagues 0, miles, fifty ſix ſeconds do anſwer unto a degree of Longitude in that Parallell, then ſetting one foot of your Compaſſes in 13 Leagues, and 56 ſeconds in your ſecond line of Longitudes, extending the other unto one degree, then with the ſame diſtance of your Compaſſes, ſet one foot in 42 Leagues and one mile of the ſame line, and the other will ſhew you 3 degrees and 13 minutes, which is the difference of the Longitude deſired.

CHAP. IV.

Two Ships departing from one Parallell, and Port, the one in ſaying eight Leagues betwixt the North, and the Weſt, hath raiſed the Pole two degrees, the other in ſailing a hundred Leagues betwixt the North, and Weſt, hath raiſed the Pole foure degrees, I demand by what Rhombes the ſaid Ships have ſaild, and the Rhombe, and diſtance that is betwixt them.

IN the fourth Demonſtration, draw the Quadrant A B C D E, then in regard the firſt Shippe hath raiſed the Pole two degrees, which is forty leagues, take forty leagues of your Scale, and apply them unto the Meridian line A G L, from A, unto G, then from the point G, draw the line G F, parallell unto A B, then opening your compaſſes unto 80 Leagues ſet one foot in the Centre A, with

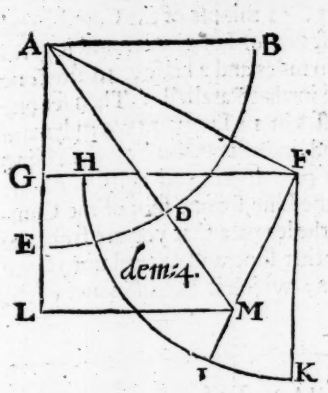
with the other, make a marke in the line G F, which will bee at F, ſo ſhall F, bee the place of the firſt ſhippe: the ſecond ſhippe hath raiſed the Pole foure degrees, which is eighty Leagues, therefore place eightie Leagues upon the Meridian line A G L, from A, unto L, and from the point L, draw the line L M, parallell unto G H F, then open your Compaſſes unto the diſtance of a hundred Leagues, which are the Leagues the ſecond ſhippe did runne, and ſet the foot of your Compaſſes in the Centre A, and with the other make a marke in the line L M, which will be at M, then draw the line M A, which is the courſe of the ſecond Ship, and the line F A, is the courſe of the firſt ſhippe, then from F, let a Perpendicular fall, being Perpendicular to the line G F, which is the line F K, then opening your Compaſſes unto the Radius of your Scale, ſet one foot in the Centre F, and with the other draw the Quadrant H I K, likewiſe from F, the place of the firſt ſhip, draw a line by the point M, the place of the ſecond ſhip: cutting the quadrāt K H I, in I, ſo let I K, be the courſe that is betwixt them, that is, if you will ſaile from the firſt ſhip unto the ſecond, you muſt ſaile North, and by Eaſt, and 41 minutes to the Eaſtward, likewiſe let F M, be the diſtance that is betwixt them, which in this Demonſtration is 40 Leagues, two miles, ſo ſhall B C, be the courſe of the firſt ſhippe from the Weſt Northward, which here is found to be 30 degrees and one minute frō the Weſt Northward, or Northweſt, by Weſt & 3 deg. and 44 min. to the Weſtward. Laſtly, the Arch E D, is in the diſtance of the courſe that the ſecond ſhip made from the North Weſtward, which is found by this Demonſtration to be Northweſt, and by North, and three degrees five minutes to the Weſtward.

CHAP.

CHAP. XV.

Two Ships departing from one Parallell and Port, in the Parallell of 47 degrees 56 minutes, the first in sayling 80 Leagues betwixt the North and West, hath raised the Pole two degrees, I demand by what course the second ship must run, and how much shee shall alter in her first Meridian or Longitude, to bring her selfe 40 Leagues and two Miles North and by East, and forty one Minutes to the Eastward of the first ship.

IN the fourth Demonstration draw the Quadrant A B C D E, then multiply your two degrees, you have altered your latitude by twenty, and it maketh forty Leagues; which forty Leagues set upon the line A E L, from A, unto G, then from the point G, draw the line G F, parallell unto A B, then open your Compasses unto the distance of 80 Leagues, which are the leagues your first ship did run, and place one foot of your Compasses in the Centre A, and with the other make a marke in the line G F, which will be at the point F, then from the Centre A, unto the point F, draw the line A F, representing the distance of the course of the first ship 80 Leagues: Then from F, let fall a perpendicular F K, and upon the Centre F, upon the Radices of the Scale draw the Arch H I K. Then in regard you must bring the second shippe North



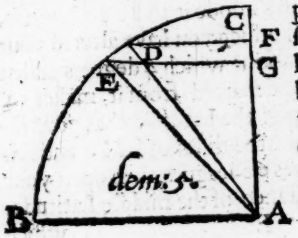
North and by East, and 41 minuts Eastward of the first ship, take 11 degrees, 56 minutes from your Scale of Coards, and place them from K, unto I upon the Quadrant K I H, Then from F, draw the line I F, and upon the line F I, place the distance that you must bring the second ship from the first (which is 40 leagues and two miles) from F, unto M, So is M, the place of your second ship. Then from M, draw the line M L, parallell unto F G, cutting the line A G L, in L, then draw the line M A, cutting the Quadrant B D E, in D, So shall the arch D E, be the course that the second ship must run, to bring her selfe 40 leagues, and two miles North and by East, and 41 minuts East of the first ship. Then to know what you have altered the Latitude, first take the distance L A, and apply it unto the Scale of equall parts, and you shall finde it to be 80 leagues, which is just 4 degrees, which you have altered your latitude, or Poles elevation: which 4 degrees added unto the Latitude you departed from it, makes 51 degrees, 56 minutes for the Latitude that your second Ship is in, then take the distance L M, and apply it to the Scale, it gives 60 leagues; then open your Compasses unto the distance of the middle Latitude,

which is 39 degrees, 51 minuts of the Coard, and apply it unto the first line of Longitudes, and it gives 12 Leagues, and two miles and a halfe, to alter one degree of Longitude in that Parallell: Then set one foot of your Compasses in 12 Leagues, two miles and an halfe in the second line of Longitudes, extending the other foot unto one degree, and with the same distance upon the same Line, set one foot of the Compasses in 60 leagues (the leagues that you are from the Meridian) and the other foot will extend unto foure degrees forty minuts, which is the difference of the Longitude.

CHAP. XVI.

To finde by Demonstration how many miles or minutes of any Parallell, doth answer unto one degree of the Equinoctiall.

LEt the Latitude given be 58 degrees 54 minuts, therefore having drawne the Quadrant A B C, from B, upon the Coard B E C, set the Latitude of the place 58 degrees 54 minuts unto the point D. Then from the point D, draw the line D F, parallell unto B A, So shall the length of the line D F, be the number of miles which answer unto one degree of Longitude in the Parallell of 58 degrees 5 minuts, which being ap-



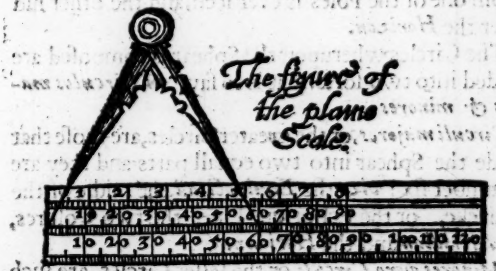
applyed unto your Scale of equall parts, gives thirty one miles. So likewise the Arke B E, being the Latitude of 52 degrees, ending in the point E, give the lines E G. For the miles that answere unto one degree of Longitude in the parallell of 52 degrees were found by the Scale to be 36 miles, and 56 seconds, or $\frac{15}{16}$ of a mile.

THE SECOND BOOK OF THE PLAIN SCALE, WHERIN

is declared the definition of the Sphear, *a description of the six great Circles, and also of the foure lesser Circles, and last of all, certaine Questions Astronomicall, performed by the said Scale.*

CHAP. I.

De *Sphera.*



The figure of the plaine Scale.

A *Spheare* according to the description of *Theodosius*, is a certain solid Superficies, in whose middle is a Point, from which all lines drawne unto the Circumference are equall; which Point is called the Centre of the Sphear, by which Centre a right Line being drawn, and extending himselfe on either

ther ſide unto that part of the Circumference wherupon the Sphear is turned, is called *Axis Sphæræ*, or the Axletree of the World.

A *Sphear* accidentally is divided into two parts, that is to ſay, *in Spheram rectam, & Spheram obliquam.*

Sphera recta, or a right Sphear, is onely unto thoſe that dwell under the *Equinoctiall*, *Quibus neuter Polorum magis altero elevatur*: that is, to whom neither of the Poles of the World are ſeen, that lie hid in the *Horizon.*

Sphæra obliqua, or an oblique Sphear, is unto thoſe that inhabit on either ſide of the *Equinoctiall*, unto whom one of the Poles is ever ſeen, and the other hid under the *Horizon.*

The Circles wherupon the Sphear is compoſed are divided into two ſorts: that is to ſay, *in Circulos majores & minores.*

Circuli majores, or the greater Circles, are thoſe that divide the Sphear into two equall parts and they are in number ſix: *viz.* the *Equinoctiall*, the midle of the Zodiacke, or the Ecliptique Line, the two Colures, the *Meridian* and the *Horizon.*

Minores vero Circuli, or the leſſer Circles, are ſuch as divide the Sphear into two parts, unequally: and they are foure in number; as the Tropick of *Cancer*, the Tropick of *Capricorn*: the Circle *Artike*, and the Circle *Antartike.*

CHAP.

Chap. II.

Of the four greater Circles.

THe *Equinoctiall* is a Circle that croſſeth the Poles of the World at right angles, and divideth the Sphear into two equall parts, and is called the Equinoctiall, becauſe when the Sunne commeth unto it, which is twice in the yeer, *viz. In principio Arietis & Libræ*, that is, *March* and *September*) the dayes and nights are equall throughout the whole World, whereupon it is called, *Equator diei & noctis*, the equall proportioner of the day and night artificiall: and in the figure is deſcribed by the Line C A E.

The *Meridian* is a great Circle, paſſing thorow the Poles of the World, and the Poles of the *Horizon*, or *Zenith* point over our heads, and is ſo called, becauſe that in any time of the yeare, or in any place of the World, when the Sunne (by the motion of the Heavens) cometh unto that Circle, it is noone or 12 of the Clock. And it is to be underſtood, that all townes and places that lie Eaſt and Weſt one of another, have every one a ſeverall Meridian: but all places that lie North and South one of another, have one and the ſame Meridian. This Circle is declared in the figure following by the Circle B C D E.

The *Horizon* is a Circle, dividing the ſuperiour *Hemiſphere* from the inferiour, wherupon it is called *Horizon*, that is to ſay, the bonds of ſight, or the farthеſt diſtance that the eye can ſee, and therefore it is alſo called *Circulus Hemiſpheri*. The *Horizons* are divided into two ſorts, *viz. Rectus & obliquus*, a right and

and an obliqne, or a declining *Horizon*: whereof thoſe have a right *Horizon* which have the *Equinoctiall* for their *Zenith*, and the Poles of the World in their *Horizon*: Becauſe the *Horizon* (hiding both the Poles of the World) is a Circle ſuppoſed to be drawne by the Poles of the World, dividing the *Equinoctiall* at right angles, as in the figure following you may plainly ſee. Firſt, imagining the Circle X V Y W, to be the earth, and thoſe that inhabit at the Point V, have the line B D, for their *Horizon*, cutting the *Equinoctiall* C A E, at right angles in A, and therefore is called *Horizon rectus & Sphæra recta*, a right *Horizon*, and a right *Sphæare*. Thoſe have an oblique *Sphæare*, or an oblique *Horizon* to whom one of the Poles are viſuall, or elevated above the *Horizon*, and have the other hid under the *Horizon*, and in regard ſuch a *Horizon* doth croſſe the *Equinoctiall* at oblique angles, it is called *Horizon obliquus*, or a declining *Horizon*, as for example: Thoſe that inhabit at the point S, have T, for their *Zenith*, and K A L, for their *Horizon*, dividing the *Equinoctiall* C A E, at oblique angles, making the angle contained betwixt the *Horizon* A K, and the *Equinoctiall* A C, an angle of thirty eight degrees, and 28 minutes, and the angle contained betwixt the *Horizon* A L, and the Pole A D, an angle of 51 deg. 32 minutes, which is the elevation of the Pole for thoſe that inhabit at S, thoſe and all other have an oblique *Sphæare*, except they inhabit juſt under the *Equinoctiall* Circle, unto whom onely doth a right Sphear belong.

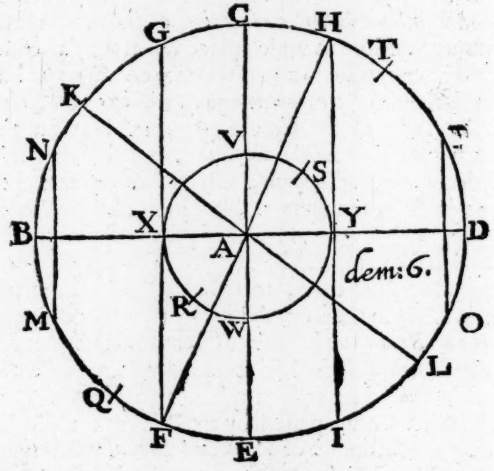
Colurus Solſtitiorum, or the Summer Colure is a Circle paſſing by the Poles of the World, and by the Poles of the Ecliptique, and by the head of *Cancer* and

and *Capricorn*, whereupon the first scruple of *Cancer* where the Colure crosseth the Ecliptique Line, is called *Punctus Solstitiæ æstivalis*, or the point of the Summer Solstice: to which place when the Sun commeth: he can approch no neerer unto our *Zenith*, but returneth unto the *Equator* again. *Arcus vero Coluri*, The Arke of the Colure contained betwixt the Summer Solstice and the *Equator*, is called the greateſt declination of the Sun, which *Ptolemie* found to be 23 degrees, 31 minutes: but by the obſervation of *Copernicus* it was found to vary, for he found the declination ſometimes to be 23 degrees 52 minutes, and in the proceſſe of time, to be but 23 degrees, 28 minutes. And in theſe our daies (by the obſervation of *Tycho de Brahe*, and that late famous Mathematician, Maſter *Edward Right*) it is found diſtant from the *Equinoctiall* 23 degrees 31 minutes 30 ſeconds.

The other Colure paſſeth by the Poles of the World, and by the firſt point of *Aries* and *Libra*, whereupon it is called, *Colurus diſtinguens Equinoxia.* Theſe two Colures doe croſſe each other at right angles in the Poles of the world, whereupon theſe Verſes were made:

Hæc duo Solſtitia faciunt Cancer, Capricornus,
Sed noctes æquant Aries & Libra diebus.

The Zodiack is another of the greater Circles, dividing the *Equinoctiall* into two equall parts, by the head of *Aries* and *Libra*, the one halfe of it doth decline unto the North, the other into the South, the greateſt of which declination is 23 degrees, 31 minutes, and 30 ſeconds. Note alſo, this Circle is divided into 12 equall parts, which parts are attributed



unto the 12 Signes, *Aries*, *Taurus*, *Gemini*, *Cancer*, *Leo*, *Virgo*, *Libra*, *Scorpio*, *Sagitarius*, *Capricornus*, *Aquarius*, & *Pisces*. And everyone of these Signes are divided into 30 equall parts, which are called degrees, so the whole Zodiake containeth 160 degrees. Likewise every degree is divided into 60 equall parts, which parts are called minutes, and are in number 21600 minutes, and as 21600 minutes is the whole circumference of the Heavens, so is 21600 miles the whole circuit of the Earth.

CHAP.

Chap. III.

Of the foure leſſer Circles.

THe Sun having aſcended unto his higheſt Solſtitiall Point doth deſcribe a Circle, which is the neereſt that he can approach unto the North Pole, wherupon it is called, *Circulus Solſtitii æſtivalis*, the Circle of the Summer Solſtice, or the Tropick of *Cancer*, and is noted in the figure before, by the line H. Y. I.

The Sun alſo approching unto the firſt ſcruple of *Capricornus*, or the Winter Solſtice, deſcribeth another Circle, which is the utmoſt bounds that the Sun can depart from the Equinoctiall Line towards the Antartike Pole, whereupon it is called, *Circulus Solſtitii hyemalis, ſive Tropicus hyemalis, vel Capricorni:* the Circle of the Winter Solſtice, the Winter Tropick, or the Tropick of *Capricorn*, and is deſcribed in the figure by the Line G. X. F.

So much as the Ecliptick declineth from the Equinoctiall, ſo much doth the Poles of the Ecliptick decline frō the Poles of the World, wherupon the Pole of the Ecliptick, which is by the North Pole of the World, deſcribeth a certain circle as it paſſeth about the Pole of the World, being juſt ſo farre from the Pole as the Tropick of *Cancer*, is from the Equator, and it is the third of the leſſer Circles, and is called, *Circulus Articus*, or the Circle of the North Pole, and is deſcribed in the *Diagram*, in the ſecond Chapter by the Line P. O.

The fourth and laſt of the leſſer Circles, is deſcribed in like manner, by the other Pole of the Ecliptick, about the South Pole of the World, and therefore

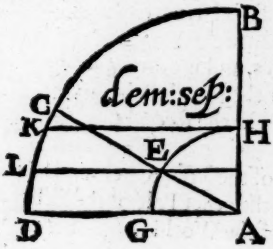
called *Circulus Antarticus*, the Antartick Circle, or the Circle of the Antartick or South Pole, and is demonstrated in the former figure, by the line N.M.

Certain questions Astronomicall performed by the plaine S C A L E.

Chap. IV.

The true place of the Sun, given to finde his declination.

THe Sun being in the head of *Taurus*, his declination is desired: by the seventh Demonstration, draw the line A.D. then upon the Centre A. raise the Perpendicular A.B. thē opening your Compasses to the Radius of your Scale, and place one foot in the Centre A. and with the other draw the Quadrant B.C.D. then opening your Compasses unto the greatest declination of the Sun, and place it upon the Quadrant from D. unto K. then from the point K. draw the Line K.H. cutting the line A. B. in H. then with the distance A.H. draw the small Quadrant G. E. H. and in regard the Sun is in the head of *Taurus*, which is thirty degrees from the beginning of *Aries*, let A. D be the Equator, and



and D the beginning of *Aries*, D. C. 30 degrees, or longitude of the Sunne, then from the point C. draw the line C. A. cutting the Quadrant G. E. H. in E then from E. draw the line E. L. parallell to A D. cutting the Quadrant B. C. D. in L. ſo ſhall the arch L. D. be the declination of the Sun deſired, which in this demonſtration is found to be 11 deg. and 31 minutes.

CHAP. V.

The declination of the Sun, and quarter of the Eclipſe that he poſſeſſeth being given, it is deſired to finde his true place.

The declination is 10 *degrees* 31 *minutes, the firſt quarter that he poſſeſſeth, is betwixt the head of* Aries *and* Cancer.

FIrſt by the ſeventh Demonſtration draw the Quadrant A. B. C. D. as is taught in the former Chapter, then ſet the greateſt declination of the Sun upon the Cord from D. unto K. which is 23 deg. and 31 minutes, then from K. draw the line K. H. parallell unto the *Equator* D. A. cutting the line B. A. in the point H. So ſhall H. A. be the ſigne of the Suns greateſt declination, then with the diſtance A. H. draw the Circle, G. E. H. then from D. upon the Cord D. B. C. ſet the declination of the Sun, which is 11 degrees, 31 min. from D. unto L. then draw the line L. E. parallell unto A. D. cutting the Quadrant G. E. H. in E. Then from the Centre A. by the point E. draw the line A. E. C. cutting the Quadrant B. C. D. in C. So ſhall the arke

C. D. be the distances of the Sunne from the head of *Aries*, which is here found to be just 30 deg. which is in the beginning of *Taurus*.

CHAP. VI.

By the elevation of the Pole, and declination of the Sun, to finde the amplitude of the Sun, or his true rising, or setting from the East or West point.

BY the eight Demonstration, first draw the line B. D. then upon the Center A. draw the Circle B.C.D. E. then from A. raise the perpendicular C.A.E. then is your Circle divided into foure equall parts: then suppose the elevation of the Pole to be 51 deg. 32 min. which must be placed upon the Circle, from D. unto F. then from the point F. by the Center A. draw the line F. A. G. representing the Pole of the World F. being the North Pole, and G. the South Pole, then substract 51 deg. 32 min. from 90 deg. and the remainder is the height of the Equinoctiall, which is 38 deg. 28 min. which must be placed upon the Circle from the Horizon B. unto the point I: then from I. by the Centre A. draw the line I. A. H. representing the Equinoctiall Circle. Then from I. unto M. set the declination of the Sun, being here supposed 14 deg. 52. min. North, then from the point M. draw the line, or Parallell of declination M. I. N. parallell unto the *Equator* I. A H. cutting the Horizon B. D. in T. then from T. raise the perpendicular T. V. cutting the Circle B.C.D.E. in V, so shall the distance C.V. be the true amplitude of the Sunne desired, which here is found to be 24 deg. 21 min. North.

CHAP.

Chap. VII.

By the Amplitude of the Sun to finde the Variation of the Compasse.

HAving found the amplitude of the Sun by the last Chapter, first observe with a Compasse, or rather with a Semicircle upon what degree and minute the Sun riseth or setteth, beginning to reckon from the East or West, & ending at the North or South at 90 degrees: and when you have diligently observed the Magneticall rising or setting, by the Semicircle, or by some other like fitting Instrument: and also the true amplitude found, as is declared in the last Chapter, the difference of these two amplitudes, is the variation of the Compasse: But when the Sunne riseth upon the same Degree of the Compasse, as is found by the Scale, the variation is nothing, but the Needle pointeth directly unto the Poles of the World, which by Master *Mulinax* was affirmed to be at the Westernmost part of Saint *Michaels*, one of the Islands of the *Azores*, from whence hee will have the Longitude reckoned. Secondly when the Sunne is in the *Equinoctiall* Circle, where hee hath no amplitude, looke what distance the Compasse maketh the Sun to rise from the East or West of the Compasse, the same distance is the Compasses variation, from the North or South. Thirdly, if the Sunne rise more to the South of the Compasse, or setteth more to the North by the compasse, then is shewed by the Scale, the difference betwixt the amplitude given by the Scale, and the ampli-

amplitude given by the Needle, is the Variation of the compaſſe from the North Weſtward. Fourthly, if the Compaſſe ſheweth the Sun to riſe more Northward, ot ſet more Southward, then is ſhewed by the Scale, the difference is the variation of the Compaſſe, from the North Eaſtward. Fiftly, if the Scale ſhew the amplitude of the Sunne riſing Southerly, and the Compaſſe ſhew it to be Northerly, adde both the Amplitudes together, and they ſhew you the variation Weſterly.

CHAP. VIII.

The place of the Sun being given, to finde his declination by a whole Circle.

ACcording unto the right Demonſtration, firſt draw the Circle B. C. D. E. then draw the Horizon B. A. D. and then the *Equinoctiall* I. A. H. as is before taught: and then the Tropick of *Cancer* K. L. 23 degrees and a halfe from the *Equinoctiall*: then draw the Tropick of *Capricorn* P. O. of like diſtance from the *Equinoctiall*, and after from K. to O. draw the Ecliptique Line K. A O. And when you have thus laid downe the Spheare, ſuppoſe the Sun to be in the tenth degree of *Taurus*, at which time his declination is deſired. And in regard the Sunne is more neere unto the Tropicall point *Cancer*, then unto *Capricorn*; firſt finde how many

many degrees he is from the Tropick of *Cancer*, and you shall finde him to be 50 degrees; therefore take with your Compasses 50 degrees from the Coard, and apply it from the Tropicall point *Cancer* at K. unto V. upon one side, and upon P. on the other side: then draw the Line V.P. cutting the Ecliptick K. O. in the point R. then from R. draw the Line M.R.N. parallell unto the Equinoctiall I. A. H. and cutting the Quadrant B. C. in the point M. So shall the Arke M. I. be the declination of the Sun desired, which being applied unto your Scale, gives you 14 degrees and 52 minutes.

CHAP. IX.

The elevation of the Pole, and declination of the Sun, given to finde his height in the verticall Circle.

The Pole is elevated 51 deg. 32 minutes, the declination of the Sun is 14 degrees 52 minutes North, his height in the verticall Circle is found as followeth.

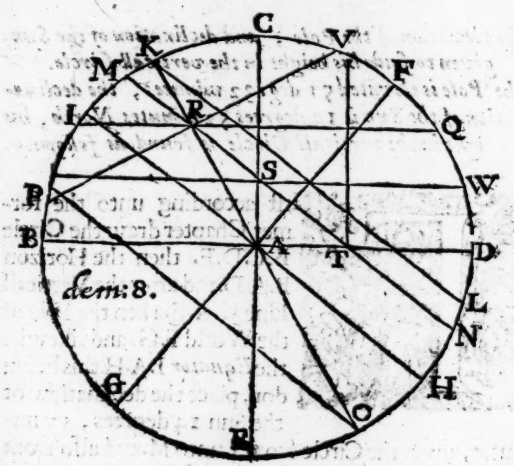
FIrst according unto the former Chapter draw the Circle B.C.D.E. then the Horizon B.A.D. and after the Verticall Line C.A.E. then the Pole of the World F.G. and likewise the *Equator* I.A.H. this being don, place the declination of the Sun 14 degrees, 52 minutes, upon the Circle from I. unto M. and also from H. unto N. then draw the Line M.N. cutting the line

C. A. E. in S. then from S. draw the Line S. W. Parallell unto the Horizon B. A. D. cutting the Meridian Circle B. C. D. E. in W. So shall the distance D. W. be the height of the Sun in the verticall Circle, for the time demanded which by this proposition is found to be 19 degrees and 8 minutes.

CHAP. X.

The elevation of the Pole, and the Amplitude of the Sun, being given, to finde the declination.

The elevation of the Pole is 51 deg. 32 min. the Suns Amplitude is 24 deg. 21 minutes, the declination is found as followeth by the eight Demonstration.



First,

FIrſt upon the Center A. draw the Circle B. C. D. E. then draw the Line B. A. D. repreſenting the Horizon, dividing the Circle into two equall parts: then draw the Line C A E, perpendicular to B A D. repreſenting the Eaſt & Weſt point of the Compaſſe, then placing the elevation of the Pole 51 degrees, and 32 minutes, from D unto F, from F, by the Centre A, draw the Line F A G, which let be the Pole or Axeltree of the World; then from B unto I, and from D unto H, ſet the complement of the Poles elevation: which ſhall repreſent the Equinoctiall, in regard it maketh right angles with the Pole of the World, in the Centre A. Then from C unto V, place the amplitude of the Sun, which is 24 degrees, and 21 minutes: then from V, let fall the perpendicular V T, cutting the Horizon B A D, in the point T: then from the point T, draw the Line M T N, parallell unto the Equinoctiall I A H: and cutting the Circle B C D E, in the point M and N, ſo let the diſtance of I and M, or H and N, be the declination of the Sun, which was deſired: which being applied unto your Scale, gives you 14 degrees, and 52 minutes.

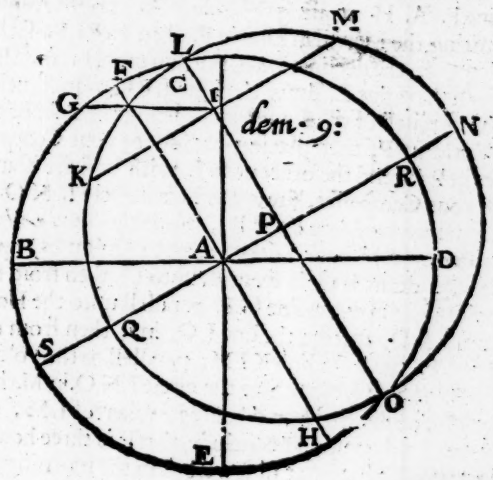
Chap. XI.

The elevation of the Pole, the declination of the Sunne, and houre of the day being given to finde the Almicanter is desired.

The elevation of the Pole is 30 degrees, the declination of the Sun is 20 degrees North, the houre is nine in the morning, at which time the Almicanter is found, as followeth.

BY the ninth Demonstration, first upon the centre A, draw the circle B C D E, then draw the Line B.D. for the Horizon, then place your Poles elevation which is 30 degrees upon the circle from D, unto R, then from R by the Centre A, draw the Line R A S, representing the Pole of the World, then from B unto F, place the Complement of the Poles elevation, which is 60. degrees, and from the point F, by the Centre A, draw the line F A H, representing the Equinoctiall Line, and then set the declination of the Sun from F, unto L, and from L draw the Line L P O, parallell unto the *Equator* F A H, cutting the Pole of the world in the point P, then set one foot of your Compasses in the point P, and extend the other either unto L, or unto O, and with the same distance of your Compasses, upon the centre P, draw the circle L N O Q, which is called the houre circle, so shall L, be the point of 12 a clock at noone, N, the place of six a clock afternoone, O the place of 12 a clock at midnight, and Q, the place of six a clock in the morning: Every one of the foure quarters, must be

be divided into ſix equall parts, or houres, making the whole circle to containe 24 parts, repreſenting the 24 houres of the day and night, then in regard the houre of the day was 9 of the clock, which is 3 hours forenoone, take three of thoſe 24 houres, and place them upon the circle L N O Q, from the Meridian point L, unto K, the nine a clock point in the morning, and unto M, the point of three a clock after noon, then draw the line M K, cutting the parallell of the Sun L O, in the point I, then from I, draw the line I G, parallell unto the Horizon B A D, which ſhall cut the Meridian circle B C D E, in the point G, ſo let the diſtance of G and B, be the Almicanter of the Sun which was deſired, which in this Demonſtration is found to be 48 degrees and 18 minutes.



CHAP.

CHAP. XII.

The elevation of the Pole, the Almicanter, and declination of the Sun, being given to finde the houre of the day.

The elevation of the Pole is 30 degrees, the declination of the Sun is 20 degrees, the Almicanter of the Sun is 48. degrees, and 18 minutes, the houre of the day is found as followeth, by the ninth Demonstration.

FIrst, upon the centre A. draw the circle B. C. D. E. then draw the Diameter B. D. representing the Horizon, then from D. unto R. set 30 degrees, the elevation of the Pole, then from R. by the Point A. draw the line R. A. S. representing the Pole of the World, then draw the line F. A. H. crossing the Pole in A. at right Angles, cutting the Meredian Line in F. then from F. set 20 degrees, the declination of the Sun unto L. and then from the point L, draw the Line L P O, representing the parallell of the Sunne, and cutting the Pole of the World in P, then placing one foot of your Compasses in P, extend the other unto L, with which distance of your Compasses, draw the houre circle I, N O Q, then from the Horizon at B, place the Suns *Almicanter:* (which is 48 degrees, and 18 minutes) upon the Quadrant B G L, from B, unto G, then from the point G, draw the line G I, parallell unto the Horizon B A D, cutting the line L O, in I, then from the point I, draw the line K I M, parallell to the Pole of the World Q A N, cutting the circle L N O, in M, then let I N, be divided into 6 houres, whereof L M, are three: whereupon I conclude, that it is three houres from noon, that is, at nine a clock in the morning, or three in the afternoone.

CHAP.

Chap. XIII.

The Almicanter, or height of the Sun being given, to finde the length of the right ſhadow.

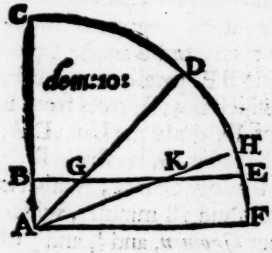
According unto the tenth Diagram, draw the Line A F, and upon the centre A, raiſe the perpendicular A C; then upon the centre A, draw the Quadrant C D F. then ſuppoſe the height of your *Gnomon*, or ſubſtance yielding ſhadow be the Line A B, which is to be divided into 12 equall parts, which *Gnomon* I have heere made juſt 12 degrees of the equall League of the Scale: then from B to the top of the *Gnomon*, draw the Line B E, parallell unto A F, then ſet the *Almicanter* which is 45 degrees from F unto D, and from the point D, draw the Line D A, cutting the Line B E, in the point G, ſo ſhall B G be the length of the right ſhadow deſired, which is heere found to be 14 degrees and 18 minutes, which is but juſt the length of your *Gnomon*, and $\frac{2}{15}$ and $\frac{1}{3}$ of a twelfth over: Note that the right ſhadow, is the ſhadow of any Poſt, Staffe, or Steeple, that ſtandeth at right angles with the Horizon, the one end thereof reſpecting the Zenith of the place, and the other the *Nadir*.

Chap.

CHAP. XIV.

The Almicanter, or height of the Sun being given to finde the length of the contrary ſhadow.

BY the verſe or contrary ſhadow, is underſtood the length of any ſhadow, that is made by a Staffe or *Gnomon* ſtanding againſt any perpendicular wall, in ſuch a manner that it may lie parallell unto the Horizon, the length of the contrary ſhadow, doth increaſe as the Sunne riſeth in height: whereas contrariwiſe the right ſhadow doth decreaſe in length, as the Sun doth increaſe in height: the way to find the verſe ſhadow is as followeth. Firſt, draw your Quadrant as is taught in the laſt Chapter wherin let A, B, be the length of the *Gnomon*, likewiſe from B, draw the line B E, parallell unto A F, as before, then ſet your *Almicanter* from C, upon the Quadrant which is given to be 70 degrees, and it will extend from C, unto H, then from the point H, draw the line H A, cutting the line B E, in the point K, ſo ſhall K B, be the length of the contrary ſhadow, which here is found to be 34 degrees and 8 min. or twice ſo long as your *Gnomon*, and $\frac{10}{13}$ and about $\frac{1}{3}$ part of a twelfth more.



CHAP.

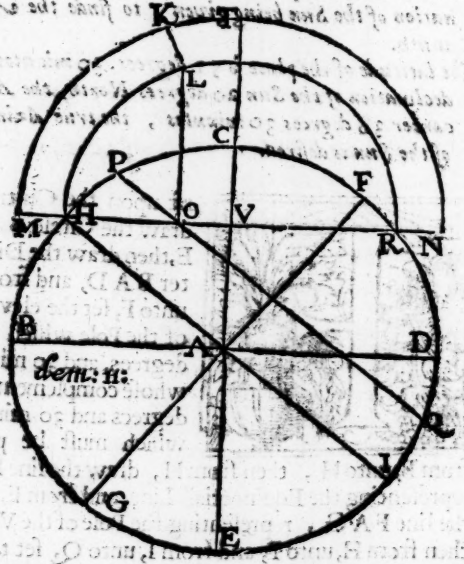
Chap. XV.

The latitude of the place, the Almicanter, and declination of the Sun being given, to finde the Azimuth.

The latitude of the place is 51 degrees, 30 minutes, the declination of the Sun 20 degrees North, the Almicanter 38 degrees 30 minutes, the true Azimuth of the Sun is desired.

Irſt upon the Centre A. draw the Circle B C D E, then draw the Diameter B A D, and from D, unto F, ſet the elevation of the Pole which is 51 degrees, and 30 minutes whoſe complement is 38 degrees and 30 minutes, which muſt be placed from B, unto H, then from H, draw the line H A I, repreſenting the Equinoctiall Line, and from F, draw the line F A G, repreſenting the Pole of the World, then from H, unto P, and from I, unto Q, ſet the declination of the Sun, which is 20 degrees, and by thoſe two points draw the line P Q, for the Parallell of the Suns declination; then upon the Circle from B, unto H. ſet the Suns Almicanter, 38 degrees, and 30 minutes, then from H, draw the line H R, parallell unto the Horizon, cutting the Suns Parallell P O, Q. in O, then draw the line T V A E, Perpendicular unto the line B A D, in the Centre A, and cutting the line H V R, in V, then ſet one foot of your

Compasses in the point V, extend the other unto R, and with the same distance draw the Semicircle H,



L R, then draw the Concentrick Circle upon the Radius of the Scale M T N, and where the line P O Q, and the line M O N, doe meet in the point V, raise the Perpendicular O L, cutting the Semicirele H L R, in L, then lay the Scale from the Centre N, to the point L, and draw the Line L K, cutting the Semicircle M T N, in K, so shall K T, be the true distance of the Sun, from the East, or West point Southward, or the

the Suns true Azimuth, which is here found to be 72 degrees, and 10 minutes from the South part of the Meridian.

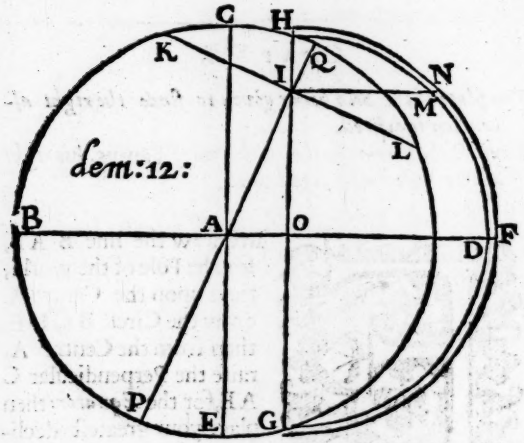
CHAP. XVI.

The place of the Sun being given to finde the right aſcention is deſired.

Suppoſe the Sun be in the 20 degree of Taurus, *his right aſcention is found as followeth.*

Firſt draw the line B A F, for the Pole of the world, then upon the Centre A, draw the Circle B C D E, then from the Centre A, raiſe the Perpendicular C A E, for the *Equator*: then place your greateſt declination frō C, unto Q, and from E, unto P, then draw the line Q A P, which doth repreſent the Ecliptick line, then in regard the Sunne is in the 20 degree of *Taurus*, which is 40 degrees, from the head of *Cancer*, which 40 degrees place from Q, unto L, and unto K, then draw the line K L, cutting the Ecliptick in I, then from the point I, draw the line H I, parallell unto C A E, cutting the Pole of the World in O, then ſet one foot of your Compaſſes in O, and extend the other unto G, with which diſtance draw the Semicircle H D G, then opening your Compaſſes unto the Radius of the Scale, and upon the Centre O, likewiſe draw the Circle H N F G, then draw the

line I M, parallell unto A O D, cutting the Semicircle H M D G, in M, then lay your Scale from the



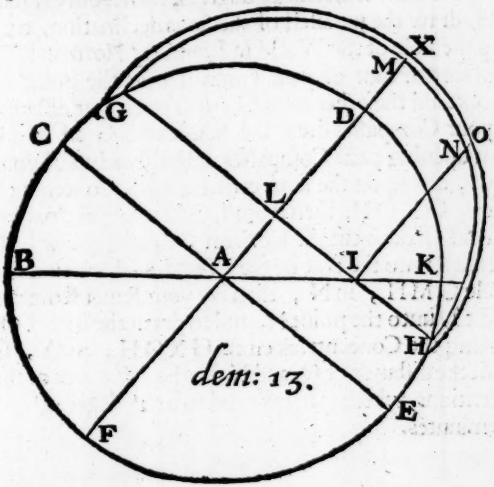
Centre O, unto the point M, and draw the Line N M, cutting the Concentrick Circle in N, so shall the distance N F, be the right ascention, which is here found to be 42 degrees, 27 minutes.

CHAP.

CHAP. XVIII.

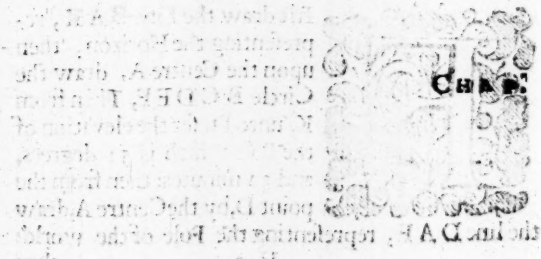
The elevation of the Pole, and declination of the Sun, given to finde the difference of the ascentions.

The Poles elevation is 51 *degrees* 32 *minutes, the declination of the Sun is* 21 *degrees.*



FIrst draw the Line B A K, representing the Horizon, then upon the Centre A, draw the Circle B C D E F, Then from K, unto D, set the elevation of the Pole which is 51 degrees, and 32 minutes: then from the point D, by the Centre A, draw the line D A F, representing the Pole of the world:

then from R, unto C, set the complement of the Poles elevation which is 38 degrees, and 26 minutes: then from C, by the Centre A, draw the line C A E, representing the Equinoctiall Line; then from C, unto G, and likewise from E, unto H, for the declination of the Sun, which is 21 degrees, then from G, unto H, draw the parallell of the Suns declination, cutting the Pole of the World in L, and the Horizon in I, then set one foot of your compasses in the point L, and extend the other unto G, then with that distance of your Compasses draw the Semicircle G M N H, then opening your Compasses unto the radius of your Scale, and upon the same centre draw a Concentrick circle, G X O H, then from I, where the declnation of the Sun doth cut the Horizon, draw the line I N, parallell unto the Pole of the World A M, cutting the circle G M H, in N, then lay your Ruler from the point I, unto the point N, and so draw the line N O, cutting the Concentrick circle G X O H, in O, so shall the distance of O, and X, be the difference of the ascentions, which is here found to be 28 degrees, and 54 minutes.



CHAP.

Chap. XVIII.

The right ascension of the Sun or Starre being given, together with the difference of their ascensions, to finde the oblique ascension.

THe right ascention of any point of the Heavens being knowne, the difference of the ascention is either to be added thereunto or else to be substracted from it, according as the Starre is situate in the Northerne or Southerne Signes: As for example, if the Sun be in any of these six Signes, *Aries*, *Taurus*, *Gemini*, *Cancer*, *Leo*, or *Virgo*, then the difference of the ascentions is to be substracted from the right ascention, and the remainder is the oblique ascention. Suppose therefore the Sunne to be in the fourth degree of *Gemini*, where the right ascention is found to be foure houres, and 8 minutes, or 62 degrees, and the difference of ascention where the Pole is elevated 51 degrees, is found to be one houre 53 minutes otherwise 28 degrees 53 minutes, which being taken from the right ascention, leaves two houres, and 16 minutes, or 33 degrees, and 42 minutes, which is the oblique ascention of the Sun in the fourth degree of *Gemini*. But if the Sun be upon the South side of the Equinoctiall, either in *Libra*, *Scorpio*, *Sagitarius*, *Capricornus*, *Aquarius*, or *Pisces*, then the difference of the ascentions is to be added unto the right ascention, and the Product will be the oblique ascention. Suppose the fourth degree of *Sagitarius*, is given, for which signe and degree the oblique ascention of the Sun is desired,

red, his right ascention being then found to be 242 degrees, or 16 houres, 8, minutes, the difference of the ascention is one houre, 53 minutes, or 28 degrees, 18 minutes. which being added unto the right ascention, makes 18 houres, and one minute; or in degrees 270 degrees, and 18 minutes: which is the oblique ascention of the Sun, when he is in the fourth degree of *Sagitarius*. And if you would finde the oblique descention, you must adde the difference of the ascentions unto the right ascention, when the Sun is in these six Signes, *Aries, Taurus, Gemini, Cancer, Leo, Virgo:* and contrariwise, when the Sunne is in the other six Signes, you must substract the difference from the right ascention, and you shal have the oblique descention of the Sun, or any Starre, whose right ascention and difference of ascentions is knowne. But it is to be understood, that this manner of operations doth serve no longer then you are upon the North side of the Equinoctiall. For if the South Pole be elevated, the worke is contrary: for so long as the Sun is in any of the Northerne Signes, the difference of the ascentions is to be added unto the right ascention, to finde the oblique ascention. And contrariwise, substracted to finde the oblique descention. Likewise if the Sun or Starre be in the Southerne Signes, then is the difference of ascentions, substracted from the right ascention, to finde the oblique ascention, and added, to finde the oblique descention.

A Description of some peculiar things, *fit to be considered, by such as intend to practise the Art of Navigation, or Astronomie.*

THE Zenith is an imaginary point in the Heavens over our heads, making right Angles with the Horizon, as the Equinoctiall maketh with the Pole.

The *Nader* is a prick in the Heavens under our feet, making right Angles with the Horizon under the earth, as the Zenith doth above; and therefore is opposite unto the Zenith.

The declination of the Sun, is the Arke of a Circle contained betwixt the Ecliptick and the Equinoctial, making right Angles with the Equinoctiall. But the declination of a Starre, is the Arke of a Circle let fall from the Centre of a Starre, perpendicularly unto the Equinoctiall.

The Latitude is the Arke of a Circle contained betwixt the Centre of any Star, and the Ecliptick Line

making right Angles with the Ecliptick, and counted either Northward, or Southward, according to the situation of the Star, whether it be nearer unto the North or South Pole of the Ecliptick.

The Latitude of a Town or Country, is the height of the Pole above the Horizon, or the distance betwixt the Zenith and the Equinoctiall.

The Longitude of a Star, is that part of the Ecliptick, which is contained betwixt the Starres place in the Ecliptick, and the beginning of ♈ *ris* counting them from *Aries* according to the succession or order of the Signes.

The Longitude of a Towne or Countrey are the number of degrees, which are contained in the Equinoctiall, betwixt the Meridian that passeth over the Iles of *Azores*, (from whence the beginning of Longitude is accounted) Eastwards, and the Meridian that passeth over the Town or Country desired.

The Altitude of the Sun or Star, is the Arch of a circle contained betwixt the Centre of the Sun, or any Starre, and the Horizon.

The Amplitude is that part of the Horizon which is betwixt the two East or west points, and the point of the Compasse that the Sun or any Star doth rise or set upon.

Azimuthes are Circles, which meet together in the Zenith, and crosse the Horizon at right Angles, and serve to finde the point of the Compasse, which the Sun is upon at any houre of the day, or the Azimuth of the Sun or Star, is a part of the Horizon contained betwixt the true East or West point, and that Azimuth which passeth by the Centre of the same Starre to the Horizon.

The right ascention of a Starre is that part of the Equi-

Equinoctiall that riſeth or ſetteth with the Star, in a right Sphear, or in an oblique Sphear, it is that portion of the Equinoctiall, contained betwixt the beginning of *Aries*, and that place of the Equinoctiall, which paſſeth by the Meridian with the centre of the Starre.

The oblique aſcention is a part of the Equinoctiall, contained betwixt the beginning of *Aries*, and that part of the Equinoctiall that riſeth with the centre of a Starre, in an oblique Sphear.

The difference aſcentionall, is the difference betwixt the right and oblique aſcention: or it is the number of degrees contained betwixt that place of the Equinoctiall that riſeth with a Centre of a ſtarre, and that place of the Equinoctiall that commeth unto the Meridian, with the Centre of the ſame ſtar.

Almicanterabs, are Circles drawne parallell unto the Horizon, one over another untill you come unto the Zenith: theſe are Circles that do meaſure the elevation of the Pole, or height of the Sun, Moon, or Stars above the Horizon, which is called the *Almicanter* of the Sun, Moon, or Star: the Arke of the Sun or Stars *Almicanter*, is a portion of an Azimuth contained betwixt that *Almicanter* which paſſeth thorow the centre of the ſtar, and the Horizon.

A generall Table for the Tides in all places.

The Moons age.	Hours and Minutes to be added.		The Moons age.	Hours and Minutes to be added.	
Dayes.	Degrees.	Minutes.	Dayes	Degrees.	Minutes.
1	0	48	16	0	48
2	1	36	17	1	36
3	2	24	18	2	24
4	3	21	19	3	12
5	4	0	20	4	0
6	4	48	21	4	48
7	5	36	22	5	36
8	6	24	23	6	24
9	7	12	24	7	12
10	8	0	25	8	0
11	8	48	26	8	48
12	9	36	27	9	36
13	10	24	28	10	24
14	11	12	29	11	12
15	0	0	30	0	0

The uſe of the Table of the Tides.

Firſt it is to be underſtood, that by the ſwift motion of the firſt mover, the Moon and all the reſt of the Stars and Planets, are turned about the World in 24 houres, upon which ſwift motion of the Moon, the dayly motions of the Sea do depend, which motion of the Sea falleth not out alwaies at one houre, the

the reason therof is, because of the swift motion of the Moon in regard she goeth almost 13 degrees in 24 houres, and the Sun mooveth scarce one degree: which gives every day 12 degrees, that the Moon commeth slower to any point in the Heaven then the Sunne: which 12 degrees makes 48 minutes of time for the difference of every full Sea, according unto the middle motion of the Moon, which difference is here set downe in this Table for every day of the Moons age. Therfore if you would know the full Sea at any place in the World, first you must know at what houre it is full Sea at the new or full Moon; which houres and minutes keep in minde, then seek the age of the Moon as is before taught, and with the number of her age enter this Table, under the title of the Moons age, and having found her age in the Table, against it you shall find the houres and minutes which are to be added unto the time that the Moon maketh full Sea in any place, and the whole number of houres and minutes is the time that the Moon maketh full Sea in any place upon the day desired. As for ensample, I desire to know the full Sea at *London* bridge upon the 13 of *July* 1624. the age of the Moon being found as before, is eight daies, then in the Table I finde eight daies, and against it 6 houres, and 24 minutes, which being added unto 3 houres, the full Sea upon the change day gives 9 a clock, 24 minutes for the time at the full Sea upon the 13 day of *July* 1624.

FINIS.